We claim:

1. A polymer nanoparticle comprising:
   a. an inner layer including alkenylbenzene monomer units,
   b. an outer layer including monomer units selected from the group consisting of conjugated diene, alkylene, alkenylbenzenes, and mixtures thereof,
   c. at least one functional group associated with said outer layer, and
   d. at least one metal complexed with said functional group.

2. The composition of claim 1 wherein said nanoparticles are substantially monodisperse.

3. The composition of claim 1 futher including a core comprised of conjugated diene and vinylstyrene monomer units.

4. The composition of claim 1 wherein said alkenylbenzene monomer units are selected from the group consisting of styrene, α-methyl styrene, 1-vinyl naphthalene, 2-vinyl naphthalene, 1-α-methyl vinyl naphthalene, 2-α-methyl vinyl naphthalene, vinyl toluene, methoxystyrene, &-butoxystyrene, and the like, as well as alkyl, cycloalkyl, aryl, alkaryl, and aralkyl derivatives thereof, in which the total number of carbon atoms in the combined hydrocarbon is not greater than 18, as well as any di-or tri-substituted aromatic hydrocarbons, and mixtures thereof.

5. The composition of claim 1 wherein said alkylene monomer units are formed by hydrogenating said conjugated diene monomer units.

6. The composition of claim 1 wherein said functional group is polar.

7. The composition of claim 1 wherein said functional group is selected from the group consisting of maleimide, hydroxyl, carboxy, formyl, azocarboxy, epoxide, amino, and mixtures thereof.

8. The composition of claim 1 wherein said metal is selected from the group consisting of Cu, Ti, Fe, Cd, Ni, Pd, and mixtures thereof.

9. The composition of claim 1 wherein said nanoparticles are crosslinked.

10. The composition of claim 1 wherein said nanoparticles have a mean average diameter of less than about 100 nm.

11. A process for forming polymer nanoparticles comprising:

a. polymerizing alkenylbenzene monomer and conjugated diene monomer in a hydrocarbon solvent to form a diblock polymer;

b. forming micelles of said diblock polymer;

c. adding at least one cross-linking agent to the micelles to form crosslinked nanoparticles, said nanoparticles having an inner layer including

alkenylbenzene monomer units and a outer layer including monomer units selected from the group consisting of alkenylbenzenes, conjugated dienes, and mixtures thereof,

d. combining said nanoparticles with at least one functional group to form functionalized nanoparticles, and

e. combining said functionalized nanoparticles with a metal to cause metal nanocomposites to associate with said functional group.

12. The process of claim 11 wherein said step a is performed in the presence of a lithium initiator.

13. The process of claim 11 wherein an alkane solvent charge is made between steps b and c or during step c.

14. The process of claim 11 further including a hydrogenation step.

15. The process of claim 11 wherein said conjugated diene monomer units are selected from the group consisting of C_4-C_8 conjugated dienes and mixtures thereof.

16. The process of claim 11 wherein said alkenylbenzene monomer units of the inner layer and outer layer are independently selected from the group consisting of styrene, α-methyl styrene, 1-vinyl naphthalene, 2-vinyl

naphthalene, 1-α-methyl vinyl naphthalene, 2-α-methyl vinyl naphthalene, vinyl toluene, methoxystyrene, &-butoxystyrene, and the like, as well as alkyl, cycloalkyl, aryl, alkaryl, and aralkyl derivatives thereof, in which the total number of carbon atoms in the combined hydrocarbon is not greater than 18, as well as any di-or tri-substituted aromatic hydrocarbons, and mixtures thereof.

17. The process of claim 11 wherein said functional group is selected from the maleimide, hydroxyl, carboxy, formyl, azocarboxy, epoxide, amino, and mixtures thereof.

18. The process of claim 17 wherein said functional group is provided by a dicarboxylic anhydride selected from the group consisting of anhydride, acetic anhydride, succinic anhydride, phthalic anhydride, oxalic anhydride, malonic anhydride, glutaric anhydride, dimethyl malonic anhydride, adipic anhydride, pimelic anhydride, α,α-dimethyl succinic anhydride, sebacic anhydride, fumaric anhydride, itaconic anhydride, citraconic anhydride, isophthalic anhydride, telephthalic anhydride, tetrachloroterephthalic anhydride, and mixtures thereof, hydroxyl, carboxy, formyl, azocarboxy, epoxide, amino, and mixtures thereof.

19. The process of claim 11 wherein said metal is selected from the group consisting of Cu, Ti, Fe, Cd, Ni, Pd, and mixtures thereof.

20. The process of claim 11 wherein step d is performed before step c.

21. The process of claim 11 further comprising releasing said metal nanocomposites from said functionalized nanoparticle by performing a solvent change.

22. The process of claim 11 wherein said metal nanocomposite has a mean average diameter between about 0.1 and 50 nm.

23. A metal nanocomposite formed by the steps comprising:

a. polymerizing alkenylbenzene and conjugated diene monomer in a hydrocarbon solvent to form a diblock polymer;

b. forming a mixture including micelles of said diblock polymer;

c. adding at least one cross-linking agent to the mixture to form crosslinked nanoparticles from said micelles, said nanoparticles having an inner layer including monomer units selected from the group consisting of alkenylbenzenes, conjugated dienes, and mixtures thereof,

d. combining said nanoparticles with at least one monomer having a functional group to form functionalized nanoparticles

e. contacting said functionalized nanoparticles with a metal such that said metal complexes with said functional group, and

f. releasing metal nanocomposites from said functionalized nanoparticle by performing a solvent change.

24. The metal nanocomposite of claim 22 wherein said metal nanocomposite includes at least one metal selected from the group consisting of Cu, Ti, Fe, Cd, Ni, Pd, and mixtures thereof.